Field Experiment to Evaluate the Response of Different Varieties of Wheat against Spot Blotch (*Bipolaris sorokiniana*) at Bhairahawa, Nepal

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ABSTRACT

Spot blotch incited by *Bipolaris sorokiniana* is one of the most important foliar disease limiting wheat production in Nepal. A field experiment was conducted from 13 December 2017 to 12 April 2018 in the research field of National Wheat Research Program (NWRP), Padsari-1 Rupandehi, Nepal to evaluate response of 12 wheat varieties against spot blotch caused by *Bipolaris sorokiniana*. The experiment was laid out in Randomized complete block design (RCBD) with 12 treatments and three replications. Individual treatment plot was 2 m² and total research field area was 152.5 m². Disease scoring was done by double digit scoring starting from heading stage in which 4 scorings were done at 7 days interval following Zadok scale. Different traits taken for scoring were lesion size, lesion mimic, leaf tip necrosis, spike length, peduncle extrusion at different growth stages. Days to heading, days to maturity, 50 spike yield, and plot yield and test weight were recorded. The mean AUDPC was calculated and analyzed. Varieties differed significantly in mean AUDPC values. On the basis of mean AUDPC value, the varieties were categorized under four categories i.e., resistant, moderately resistant, susceptible and highly susceptible. Furthermore, the correlation of 12 varieties with AUDPC and various traits was analyzed. There was negative correlation between AUDPC and yield i.e. -0.62050. Among 12 varieties, RR-21 showed highest level of disease increment with AUDPC value 974.897 and found to be the most susceptible while least was observed in Danphe with AUDPC value 383.7 and found to be resistant. Badhganga with the AUDPC value of 396.517 was also found to be resistant to spot blotch. No varieties were found highly resistant. Similarly, Swargadwari, Gautam, NL 971, Tilottama, Aditya, Dhaulagiri and Vijaya appeared moderately resistant to spot blotch of wheat. Bhrikuti and WK 1204 were susceptible to spot blotch. Wheat grain yield varied among the varieties. Maximum yield was recorded in Danphe (5.7 t/ha) and minimum yield was recorded in RR-21 (3.5 t/ha). Similarly, highest value of test weight was recorded in Danphe (53.43 gm) and the lowest value was in Bhrikuti (34.53 gm). So, Danphe showing better performance at Bhairahawa can be taken as the source of tolerance in upcoming experiments and RR-21 can be used as susceptible check and these varieties can be suggested to incorporate into breeding program.

Keywords: *Bipolaris sorokiniana*; Wheat; Randomized complete block design

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an annual crop belonging to the family Poaceae (Graminae) and the tribe Triticeae [1]. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. It is one of the most important and the second largest cereal of the world in terms of production (729,012,175 tons), maize (*Zea mays*) being the first with the production of 1,037,791,518 tons and rice (*Oryza sativa*) being third with the production of 739.53 million tons. The production of wheat was 754.1 million tons in 2016 and 741,477,711 tons in 2014 [2]. Wheat has wide adaptability. Wheat is a winter crop however it can be cultivated in tropical, sub-tropical as well as temperate regions. It is cultivated from sea level to as high as 3300 meters. In Nepal, it is sown in October-November and harvested in March-April.

Rupandehi is a major wheat producing district of Nepal and occupies 29,400 ha under wheat with a production of 79,380 Mt and productivity 2700 kg/ha (Table 1).

The demand for wheat is getting higher with the increase in world's population. To meet the increasing demand to feed the world, there is limited possibility of expanding the area under wheat cultivation. The gap of demand and supply can be reduced with proper provision for crop protection along with high yielding varieties.

Table 1: Area, production and productivity of wheat in Nepal.

Year	Area (ha)	Production (Mt)	Productivity(Mt/ha)
2011/12	765,317	1,846,142	2,412
2012/13	759,843	1,882,220	2,477
2013/14	754,474	1,883,147	2,496
2014/15	762,373	1,975,625	2,591
2015/16	745,823	1,736,849	2,329

Source: (Statistical Information on Nepalese Agriculture, 2015/16).

There are several constraints to gain the maximum yield; abiotic and biotic constraints. Among the biotic constraints spot blotch is of major importance in context of Nepal. Spot blotch incited by fungal pathogen *Bipolaris sorokiniana (anamorph)* and *Cochliobolus sativus (teleomorph)* is one of the most important foliar disease of wheat limiting the wheat production in Southeast Asia. Lesions are characterized by small, dark brown spots 1 to 2 mm long without chlorotic margin in beginning which enlarge a few centimeters and finally coalesce to form brown, irregular stripes. Disease appear as spots on seedling, plant crowns, stems, leaves, floral parts and kernels [3-8].

Symptoms caused by *C. sativus* were first observed in seedling stage. Yield loss varies from 15.5-19.6% to 20-80%. Research conducted on-station in NARC; Bhairahawa, Nepal showed losses of 24% to 27% in highly susceptible varieties and on-farm studies indicated up to 16% loss [7].

Spot blotch can be managed by improving soil fertility, crop rotation, residue management, chemical control and use of breeding resistant cultivars. The best, long term and environmentally safe method for sustainable disease control is the use of resistant varieties. Identification of resistant varieties on a continuous basis would be the best alternative to manage spot blotch.

In this study, an attempt has been made to characterize 12 varieties of wheat against spot blotch at NWRP, Bhairahawa.

Our study has following four objectives:

- To determine the prevalence of spot blotch of wheat.

- To estimate disease severity and intensity on different wheat varieties.

- To determine the effect of seed borne *Bipolaris sorokiniana* on yield.

- To find the most resistant varieties among 12 varieties.

MATERIALS AND METHODS

Site: National Wheat Research Program (NWRP), Padsari-1, Rupandehi, Nepal.

Disease: Spot blotch

Varieties: 12 (Bhrikuti, Gautam, Aditya, NL 971, Vijaya, Tilottama, Danphe, Badhganga, Swargadwari, WK 1204, Dhaulagiri and RR 21).

Experimental design

The experiment was conducted in Randomized Complete Block Design (RCBD) with 12 treatments and 3 replications. Individual plot was 2 m² (2m × 1m) with row to row spacing of 25 cm and

plant to plant spacing of 5 cm. The total area of the field was 152.5 m² (30.5m × 5m). The spacing between two replication was 50 cm and treatment spacing of 50 cm with the field margin 50 cm in all sides. The total length of the experimental design was 30.5 m and breadth of 5 m.

Twelve different varieties of wheat namely Bhrikuti, Gautam, Aditya, NL 971, Vijaya, Tilottama, Danphe, Badhganga, Swargadwari, WK 1204, Dhaulagiri and RR 21 were collected from NWRP. Land was thoroughly ploughed and leveled. Sowing of the seed was done on 13 December 2017. The scheduling of irrigation to wheat is based on physiological growth stages which are critical in demand of water. Regular field visit and rogueing of off-type cultivar was done. Disease scoring was done by randomly selecting 10 plants, which were tagged in each plot. Plants were assessed and evaluated against spot blotch disease under artificial condition. Disease scoring was done after first appearance of the spot blotch disease symptom at an interval of about 7 days. Double digit scoring was taken to calculate the area under the disease progress curve (AUDPC) value.

Agronomic attributes such as vegetative stages, leaf area (LA), plant height (PH), spike length (SL), peduncle extrusion (PE), leaf tip necrosis (LTN), lesion size (LS), lesion mimic (LM), etc. and yield attributes such as 50 ear yield (EY), plot yield (PY) and thousand kernel weight (TKW) were observed. Data entry and processing was carried out using MS-Excel version 2013. The raw data were processed to fit into SAS 9.4 version software for analysis [9-15] (Table 2).

RESULTS AND DISCUSSION

Area under Disease Progressive Curve (AUDPC)

Area under disease progressive curve (AUDPC) was calculated based on disease intensity recorded 1st on heading stage, 2nd on an thesis stage, 3rd on milk stage and 4th on dough stage. The treatments vary significantly in AUDPC values. Among the different varieties under study, Danphe was found to be the variety with lowest AUDPC value 383.7 followed by Badhganga with value 396.517 and RR-21 was found to be the variety with highest AUDPC value 974.897 followed by WK-1204 with AUDPC value 789.8 (Figure 1).

Some other agronomic attributes such as leaf area (LA), plant height (PH), spike length (SL), peduncle extrusion (PE), leaf tip necrosis (LTN), lesion size (LS), lesion mimic (LM), etc. and yield attributes such as 50 ear yield (EY), plot yield (PY) and thousand kernel weight (TKW) were observed and data were noted and graphs against varieties were made.

Based on mean AUDPC values on leaves of different varieties of wheat, a scale of mean AUDPC values was proposed to categorize the varieties into 5 levels as shown below (Tables 3, 4 and 5).

AUDPC and Thousand kernel weight (TKW)

The graph shows the relationship of 12 wheat varieties with Area under Disease Progressive Curve (AUDPC) and thousand kernel weight (TKW) (Figure 2).

Area under disease progressive curve (AUDPC) was calculated based on disease intensity. Treatments varied significantly in AUDPC values. Danphe had the lowest AUDPC and RR 21 had the highest AUDPC value with the mean value of 383.70 and 974.90 respectively. The maximum test weight was recorded in

Table 2: ANOVA table.

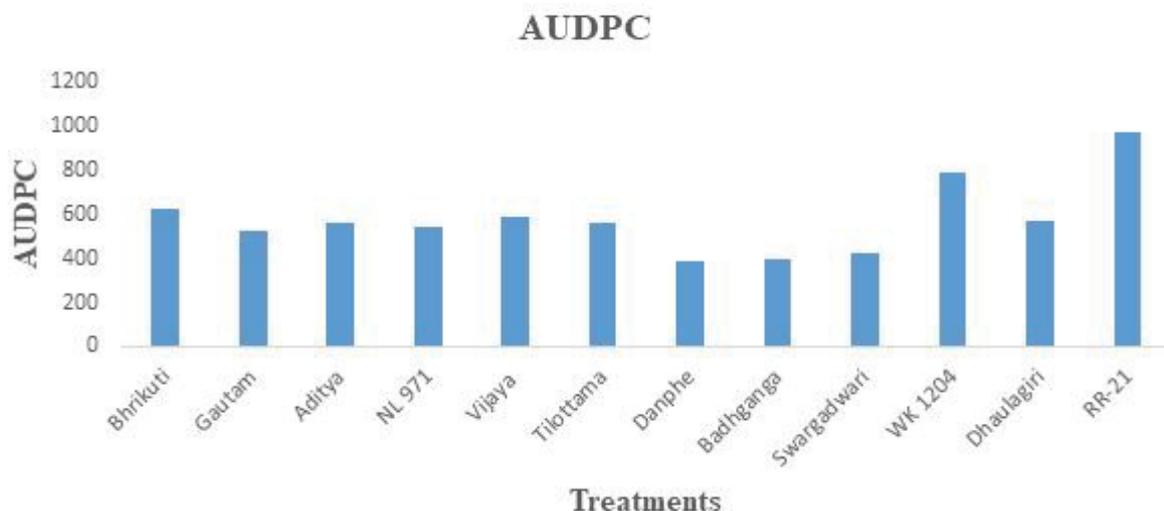| Sources	df	AUDPC	LS	LTN	LM	SL	PE	PH	LA	EY	TKW	PY	DH	DM
Genotype	11	82573.152	1.4	2.36	77.46	9.93	52.62	114.59	135.83	280.577	128.48	41225.9	28.1	1.82
Replication	2	3047.175	0.083	1.583	6.25	0.089	0.024	9.71	0.913	23.42	6.148	11229.2	0.3	1
SEM (±)	22	2857.25	0.053	0.22	9.28	1.28	0.998	6.5	5.3	43.4	8.762	6569.5	0.54	0.21
CV (%)	35	9.254	8.374	20.087	22.15	6.758	5.1	2.725	5.45	7.377	6.782	8.718	0.95	0.43

Figure 1: Graph showing area under disease progressive curve of 12 different wheat varieties at Bhairahawa during December-April 2017/2018.

Table 3: Resistant category for 12 different varieties of wheat based on mean AUDPC value.

Mean AUDPC Values	Resistant Category	Varieties
0-200	Highly resistant (HR)	-
201-400	Resistant (R)	Danphe and Badhganga
401-600	Moderately resistant (MR)	Swargadwari, Gautam, NL 971, Tilottama, Aditya, Dhaulagiri, Vijaya
601-800	Susceptible (S)	Bhrikuti and WK 1204
801-1000	Highly susceptible (HS)	RR 21

Table 4: Mean value table.

Varieties	AUDPC	LS	LTN	LM	SL	PE	PH	LA	EY	TKW	PY	DH	DM
Bhrikuti	627.983	3	1.33	18.33	14.73	16.26	90.767	46.41	75.12	34.53	4.24	78	114.33
Gautam	522.84	2	3	6.67	19.52	21.1	96.8	47.65	94.33	46.6	5.33	77	112.67
Aditya	563.17	2	2.67	16.67	16.93	19.97	99.43	42.54	84.67	41.81	4.475	76.3	113.67
NL 971	545.87	2	1.33	18.67	16.53	21.3	105.1	40.82	100.7	44.54	4.77	79	114.33
Vijaya	591.976	3	1.67	18.3	14.13	18.73	98.27	40.42	85.52	37.23	3.745	73	112.67
Tilottama	561.73	2	2.33	11.67	16.36	21.07	92.96	38.44	87.66	46.23	4.787	77	114.67
Danphe	383.7	2	3.33	8.33	19.067	21.16	95.56	23.89	104.8	53.43	5.7	83	114.67
Badhganga	396.517	3	3.33	6.67	18.253	24.37	82.76	44.97	101.5	48.82	5.122	73.67	115
Swargadwari	427.77	3	3.33	8.33	18.94	23.6	87.73	49.3	90.3	52.52	4.87	75	113.67
WK 1204	789.8	4	1.33	18.33	15.83	13.94	86.67	35.75	89.23	35.96	4.43	82.33	114.67
Dhaulagiri	567.49	3	2.67	15	15.37	14.56	95.7	45.06	81.98	46.19	4.54	75.33	114
RR-21	974.897	3.67	1.33	20	15.2	13.73	91.47	45.58	75.6	35.88	3.5	77	114.67
CV	35	9.254	25.04	20.087	22.15	6.758	5.1	2.725	5.45	7.377	6.782	8.718	0.95
LSD	90.79	0.38	0.79	5.15	1.91	1.69	4.31	3.89	11.15	5.01	0.68	1.24	0.77
Mean±S.D	579.43±167.13	2.75±0.69	2.33±0.98	13.75±5.52	16.74±1.98	19.57±4.14	93.6±6.37	41.9±6.78	89.3±10.8	43.64±6.79	4.64±0.6	77.22±3.03	114.08±0.87
Maximum	1008	4	4	20	20.2	27	105.6	50.34	112	55.49	6.21	83	115
Minimum	319.75	2	1	5	13	12.9	79.6	21.8	70.59	32	3.56	73	112

AUDPC: Area under Disease Progressive Curve, LS: Lesion Size, LTN: Leaf Tip Necrosis, SL: Spike Length, PE: Peduncle Extrusion, PH: Plant Height, LA: Leaf Area, EY: 50 Spikes/Ear Yield, TKW: Thousand Kernel Weight, PY: Plot Yield, DH: Days to Heading, DM: Days to Maturity, CV: Coefficient of Variation, LSD: Least Significant Difference, SD: Standard Deviation

Danphe (53.43 gm) and least was recorded in Bhrikuti (34.527 gm). AUDPC value of all three replication ranged from 319.75 (Danphe) to 1008.02 (RR 21). Thousand kernel weight (TKW) value among three replications ranged from 32 g (Bhrikuti) to 55.49 g (Danphe). There was significant negative correlation between the mean AUDPC and test weight. It was in accordance to findings of Kwasna [16], Sharma et al., [17], Neupane et al., [18] they found negative correlation between area under disease progressive curve

Table 5: Pearson's correlation coefficient table.

	AUDPC	LS	LTN	LM	SL	PE	PH	LA	EY	TKW	PY	DH	DM
AUDPC	1												
LS	0.57239**	1											
LTN	-0.6263**	-0.37713*	1										
LM	0.65284**	0.32699*	-0.7082**	1									
SL	-0.5689**	-0.3521*	0.66083**	-0.648**	1								
PE	-0.8228**	-0.6206**	0.6276**	-0.717**	0.665**	1							
PH	-0.05513	-0.6001**	-0.16851	0.2544*	-0.073	0.0261	1						
LA	0.14888	0.2982*	-0.02417	0.0591*	-0.0838*	-0.298*	-0.22**	1					
EY	-0.6023**	-0.3758*	0.42766**	-0.545**	0.5289**	0.684**	0.1179	-0.4094*	1				
TKW	-0.7506**	-0.4946**	0.6977**	-0.736**	0.7353**	0.749**	-0.0232	-0.1999	0.5**	1			
PY	-0.6205**	-0.3878*	0.53408**	-0.712**	0.6323**	0.657**	-0.0724	-0.3067*	0.6**	0.70**	1		
DH	0.14301	-0.04084	-0.207	0.10224	0.1023	-0.021	0.0768	-0.649**	0.22*	-0.0145	0.29*	1	
DM	0.16107	0.17716	-0.2321*	0.05175	-0.0656	0.0049	-0.367*	-0.326*	0.11	0.01	0.164	0.41*	1

** Highly significant * Significant (at 5% level of significance)
AUDPC: Area under Disease Progressive Curve, LS: Lesion Size, LTN: Leaf Tip Necrosis, SL: Spike Length, PE: Peduncle Extrusion, PH: Plant Height, LA: Leaf Area, EY: 50 Spikes/Ear Yield, TKW: Thousand Kernel Weight, PY: Plot Yield, DH: Days to Heading, DM: Days to Maturity
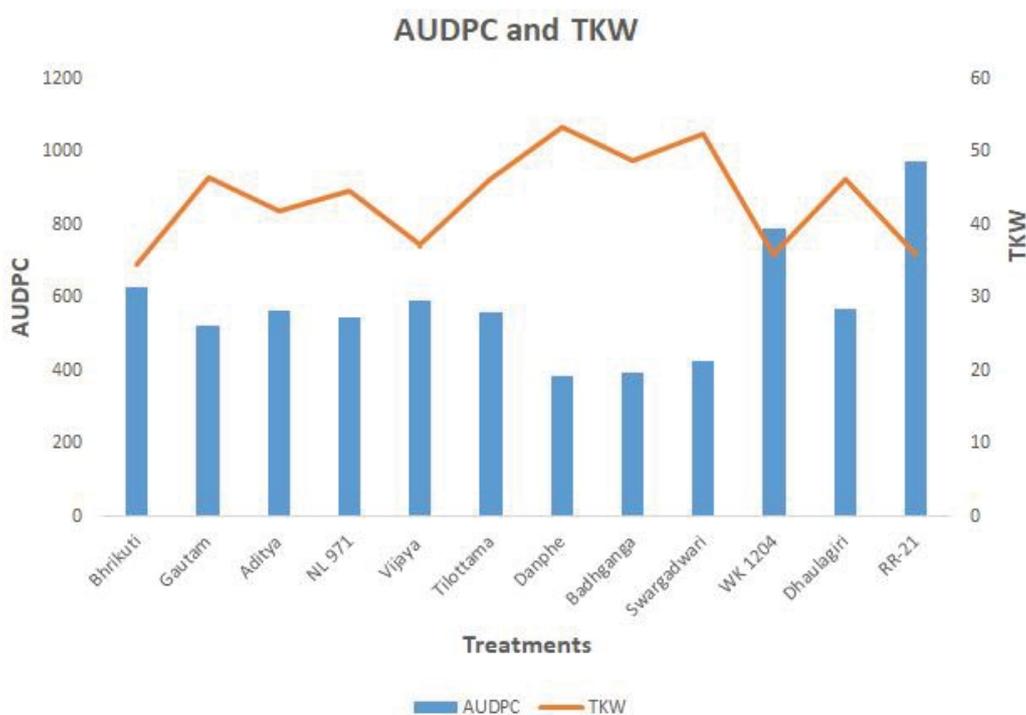

Figure 2: Graph showing area under disease progressive curve and thousand kernel weight of 12 different varieties of wheat.

and thousand kernel weight.

CONCLUSION

On the basis of mean AUDPC value, the varieties were categorized under four resistance categories i.e., resistant, moderately resistant, susceptible and highly susceptible. Among 12 varieties RR-21 (974.897) was categorized as highly susceptible. WK-1204 (789.8) and Bhrikuti (627.983) were categorized as susceptible varieties. No varieties were found highly resistant. Similarly, Swargadwari (427.77), Gautam (522.84), NL 971 (545.87), Tilottama (561.73), Aditya (563.17), Dhaulagiri (567.49) and Vijaya (591.976) appeared moderately resistant to spot blotch of wheat. In reference to the research conducted, performance of wheat varieties varied significantly with response to spot blotch in different parameters in field condition at NWRP, Bhairahawa. Among different varieties

of wheat, Danphe was found to be the most resistant followed by Badhganga against spot blotch in reference to NWRP, Bhairahawa. So, Danphe variety of wheat can be recommended for cultivation under the climatic condition of Rupandehi district. Similarly, RR-21 appeared highly susceptible to spot blotch and can be used as susceptible check and these varieties can be suggested to incorporate into breeding program.

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